

CLAIMS

1. A low-temperature fabrication method for fabricating a conformal metal oxide coating on a substrate, the method comprising the steps of:
coating a surface of a substrate with a non-hydrolysed precursor solution of one or more moisture-sensitive metal alkoxides in an organic solvent at a temperature of less than 150 °C; and
rinsing the precursor solution coated on the surface of the substrate in water at a temperature of less than 150 °C to hydrolyse precursor solution at the surface of the substrate and thereby form a conformal metal oxide coating on the substrate.
2. The method of claim 1, wherein the one or more moisture-sensitive metal alkoxides comprise $M(OR)_z$, where M is any metal, and OR is an alkoxide group.
3. The method of claim 2, wherein the metal is a metal selected from the group consisting of Al, Ce, Mg, Nb, Si, Sn, Ti, V, Zn and Zr.
4. The method of any of claims 1 to 3, wherein the step of coating a surface of a substrate is performed at room temperature.
5. The method of any of claims 1 to 4, wherein the step of coating a surface of a substrate is performed by dipping the surface of the substrate in the precursor solution.
6. The method of claim 5, wherein the surface of the substrate is dipped in the precursor solution for a period of from about 1 minute to about 1 hour.
7. The method of any of claims 1 to 4, wherein the step of coating a surface of a substrate is performed by spraying the surface of the substrate with the precursor solution.

8. The method of any of claims 1 to 4, wherein the step of coating a surface of a substrate is performed by spin-coating the surface of the substrate with the precursor solution.
9. The method of any of claims 1 to 8, wherein the precursor solution has a concentration of less than about 200 mM.
10. The method of claim 9, wherein the precursor solution has a concentration in the range of from about 1 mM to about 100 mM.
11. The method of claim 10, wherein the precursor solution has a concentration in the range of from about 5 mM to about 20 mM.
12. The method of any of claims 1 to 11, wherein the step of rinsing the precursor solution coated on the surface of the substrate is performed at room temperature.
13. The method of any of claims 1 to 12, wherein the step of rinsing the precursor solution coated on the surface of the substrate is performed by dipping the coated surface of the substrate in water.
14. The method of any of claims 1 to 13, further comprising the step of:
drying the rinsed surface of the substrate at a temperature of less than 150 °C.
15. The method of claim 14, wherein the step of drying the rinsed surface of the substrate is performed at room temperature.
16. The method of claim 14 or 15, wherein the step of drying the rinsed surface of the substrate is performed by directing a gas flow thereover.
17. The method of any of claims 1 to 16, wherein the surface of the substrate is a flat surface.

18. The method of any of claims 1 to 16, wherein the surface of the substrate comprises a structured surface.
19. The method of claim 18, wherein the structured surface comprises a nanoporous surface.
20. The method of claim 18, wherein the structured surface comprises a reticulated surface.
21. The method of any of claims 1 to 20, wherein the substrate includes a temperature-sensitive element.
22. The method of claim 21, wherein the temperature-sensitive element is selected from the group consisting of a plastic and a polymer.
23. The method of claim 21, wherein the temperature-sensitive element comprises temperature-sensitive molecules.
24. The method of claim 23, wherein the molecules are selected from the group consisting of inorganic, organic and organometallic molecules.
25. The method of claim 23, wherein the molecules are polymers.
26. The method of claim 23, wherein the molecules are biomolecules.
27. The method of claim 23, wherein the molecules are biological macromolecules.
28. The method of claim 27, wherein the biological macromolecules are selected from the group consisting of proteins and nucleic acids.
29. The method of any of claims 23 to 28, wherein the molecules are at the surface of the substrate.

30. The method of claim 29, wherein the coating extends over regions of the surface of the substrate not encompassed by the molecules.
31. The method of claim 29, wherein the coating encapsulates the molecules.
32. The method of any of claims 1 to 16, wherein the substrate comprises particles.
33. The method of claim 32, wherein the particles comprise dry particles.
34. The method of claim 32, wherein the particles are suspended in solution.
35. The method of any of claims 32 to 34, wherein the particles comprise nanoparticles.
36. The method of any of claims 1 to 35, wherein the metal oxide coating has a thickness of from about 0.2 nm to about 10 nm.
37. The method of claim 36, wherein the metal oxide coating has a thickness of from about 0.2 nm to about 1 nm.
38. A low-temperature fabrication method for fabricating a metal oxide coating on a substrate, the method comprising the steps of:
coating a surface of a substrate with a non-hydrolysed precursor solution of one or more moisture-sensitive metal alkoxides in an organic solvent at a temperature of less than 150 °C; and
hydrolysing precursor solution at the surface of the substrate to form a metal oxide coating at a temperature of less than 150 °C.
39. The method of claim 38, wherein the metal oxide coating is a conformal coating.
40. The method of claim 38 or 39, wherein the precursor solution has a concentration of less than about 200 mM.

41. The method of claim 40, wherein the precursor solution has a concentration in the range of from about 1 mM to about 100 mM.
42. The method of claim 41, wherein the precursor solution has a concentration in the range of from about 5 mM to about 20 mM.
43. The method of any of claims 38 to 42, wherein the step of hydrolysing the precursor solution coated on the surface of the substrate is performed in water.
44. The method of any of claims 38 to 43, wherein the step of hydrolysing the precursor solution coated on the surface of the substrate is performed at room temperature.
45. The method of any of claims 38 to 44, wherein the step of hydrolysing the precursor solution coated on the surface of the substrate is performed by rinsing the coated surface of the substrate.
46. The method of any of claims 38 to 45, further comprising the step of:
drying the hydrolysed surface of the substrate at a temperature of less than 150 °C.
47. The method of claim 46, wherein the step of drying the hydrolysed surface of the substrate is performed at room temperature.
48. The method of claim 46 or 47, wherein the step of drying the hydrolysed surface of the substrate is performed by directing a gas flow thereover.
49. The method of any of claims 38 to 48, wherein the metal oxide coating has a thickness of from about 0.2 nm to about 10 nm.
50. The method of claim 49, wherein the metal oxide coating has a thickness of from about 0.2 nm to about 1 nm.

51. A device incorporating a substrate having a metal oxide coating as fabricated by the method of any of claims 1 to 50.
52. The device of claim 51, wherein the device is one of an electronic or optoelectronic device.
53. The device of claim 52, wherein the device is a photovoltaic device.
54. The device of claim 53, wherein the device is a dye sensitized solar cell.
55. A dye sensitized solar cell device, comprising a nanocomposite film sandwiched between a pair of electrodes, wherein the nanocomposite film comprises a mesoporous, nanocrystalline film conformally coated with a first coating of a metal oxide and a second coating of a sensitizing dye, and a redox-active electrolyte interpenetrated into the pores of the nanocrystalline film.
56. The device of claim 55, wherein the metal oxide coating has a thickness of from about 0.2 nm to about 10 nm.
57. The device of claim 56, wherein the metal oxide coating has a thickness of from about 0.2 nm to about 1 nm.
58. The device of any of claims 55 to 57, wherein the metal oxide comprises Al_2O_3 .
59. The device of any of claims 55 to 58, wherein the nanocomposite film comprises TiO_2 .
60. The device of any of claims 55 to 59, wherein the redox-active electrolyte comprises a polymer electrolyte.
61. A non-hydrolysed precursor solution of one or more moisture-sensitive metal alkoxides in an organic solvent.

62. The precursor solution of claim 61, wherein the one or more moisture-sensitive metal alkoxides comprise $M(OR)_z$, where M is any metal, and OR is an alkoxide group.
63. The precursor solution of claim 62, wherein the metal is a metal selected from the group consisting of Al, Ce, Mg, Nb, Si, Sn, Ti, V, Zn and Zr.
64. The precursor solution of any of claims 61 to 63, wherein the precursor solution has a concentration of less than about 200 mM.
65. The precursor solution of claim 64, wherein the precursor solution has a concentration in the range of from about 1 mM to about 100 mM.
66. The precursor solution of claim 65, wherein the precursor solution has a concentration in the range of from about 5 mM to about 20 mM.
67. A method of preparing a non-hydrolysed precursor solution of one or more moisture-sensitive metal alkoxides in an organic solvent, the method comprising the step of mixing one or more moisture-sensitive metal alkoxides in an organic solvent in a controlled environment containing less than about 10 ppm water.
68. The method of claim 67, where performed at room temperature.
69. The method of claim 67 or 68, wherein the controlled environment is an inert atmosphere.
70. The method of any of claims 67 to 69, wherein the one or more moisture-sensitive metal alkoxides comprise $M(OR)_z$, where M is any metal, and OR is an alkoxide group.
71. The method of claim 70, wherein the metal is a metal selected from the group consisting of Al, Ce, Mg, Nb, Si, Sn, Ti, V, Zn and Zr.

72. The method of any of claims 67 to 71, wherein the precursor solution has a concentration of less than about 200 mM.
73. The method of claim 72, wherein the precursor solution has a concentration in the range of from about 1 mM to about 100 mM.
74. The method of claim 73, wherein the precursor solution has a concentration in the range of from about 5 mM to about 20 mM.